LOW CARBON TECHNOLOGY INVESTMENT UNDER GRANDFATHERED *VERSUS* AUCTIONED EMISSION PERMITS

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Presentation Summary

1. Motivation
2. Experimental Design
3. Preliminary Experimental Results
4. Discussion/ Next Steps

1. MOTIVATION

Tradable emission permits are the central environmental policy instrument chosen to achieve GHG emissions reductions.

- K. P.
- EU ETS
- RGGI

GHG emissions reductions, adaptation and the need to achieve a *Green Economy* still is in the agenda of international negotiations and plays a major role.

-16th COP UNFCC
- UNEP (2011)

1. MOTIVATION

Long term environmental policies designed to deal with the global climate change problem need to consider its impact on innovation and technological diffusion and vice-versa.

Dynamic instead of static efficiency should, in this case, be the criteria used for comparison between the different environmental policy instruments.

Not an argument without opponents
(Kennedy and Laplante (1995) or Zhao (2003), for example)

1. MOTIVATION

The literature shows there is **not** a unique ranking of environmental policy instruments regarding their effect on technological innovation/ adoption of green technologies.

Milliman and Prince (1989), Marin (1991), Biglaiser *et al.* (1995), Jung *et al.* (1996), Parry (1998), Requate (1998), Keohane (1999), Montero (2002), Zhao (2003), Fischer *et al.* (2003), Requate and Unold (2003), Krysiak (2006) and StorrØsten (2010), are some examples of studies with different conclusions concerning this ranking.

1. MOTIVATION

For the particular case of EPM, Laffont and Tirole (1994, 1996a and 1996b) theoretical studies, for example, conclude this policy instrument provides less than optimal incentives to innovate but *excessive* investment on existent technologies.

…. Because firms do not internalise the lost revenue imposed on other firms as a consequence of not participating in the emission permits market.

1. MOTIVATION

Also, no consensus exist about the (ir)relevance of the initial **allocation mechanisms** of emission permits for incentives to innovate/ adopt new technologies.

Milliman and Prince (1989), Jung *et al.* (1996), Albrecht (1999), for example, consider auctioned permits to be superior to grandfathered in what concerns the incentives to innovate.
Keohane (1999) and Requate and Unold (2003), for example, consider them equivalents…

Result seems to depend from the **conditions in the market.**

1. MOTIVATION

OBJECTIVE: to contribute to the empirical evidence on the relevance of initial allocation mechanisms for marketable permits, on the incentives to adopt cleaner technologies.

METHODOLOGY:
- experimental.

1. MOTIVATION

JUSTIFICATION FOR THE METHODOLOGICAL CHOICE:

Already proven to be extremely advantageous on the study of EPM. Innumerous experiments were already done to study several aspects of EPM functioning (particularly, institutional rules).

Cason (2010), for instance, summarizes the advantages of this methodology for the study of EPM.

2. EXPERIMENTAL DESIGN

Builds on Botelho, Fernandes and Pinto (2011), i.e. laboratory rules try to mimic the European Commission choices for the EU ETS implicit at the 2003/87/EC Directive:

- **cap-and-trade system**
- **banking**
- **double auction with discriminative prices (reflecting rules of exchanges)**
- **penalty structure for incompliance**

2. EXPERIMENTAL DESIGN

PARAMETERS chosen for the market intended to parallel EU ETS:

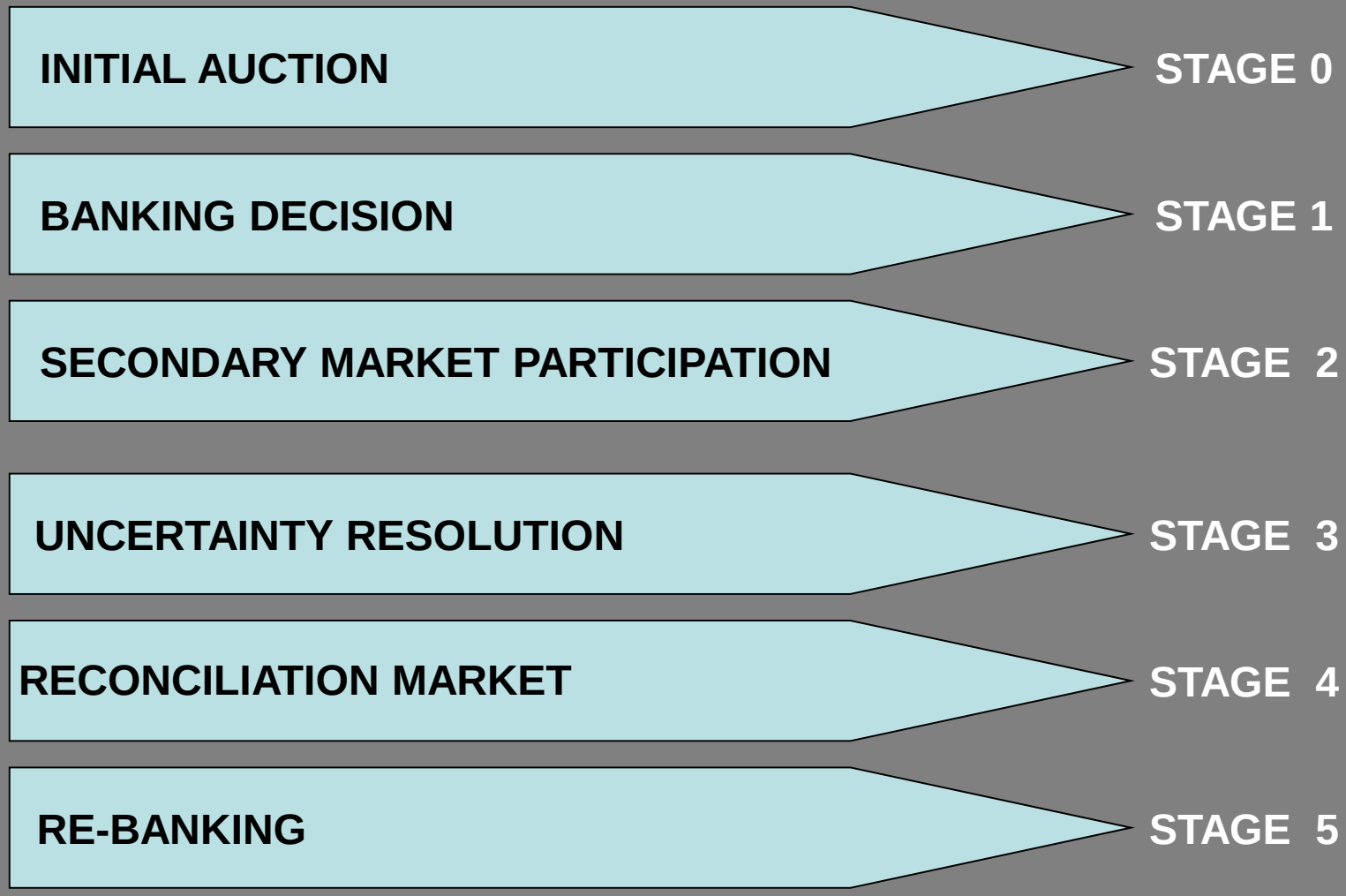
- Marginal abatement costs structure based on Eyckmans *et al.* (2000)
- Participants' dimension proportional to Belgium (S1), Spain (S2), Germany (S3), Greece (S4), France (S5), Italy (S6), United Kingdom (S7) and Netherlands (S8).
- Emissions targets fixed according to EU Burden Sharing Agreement (BSA) – but more restrictive.

2. EXPERIMENTAL DESIGN

Experimental variable (2 treatments): initial allocation rule for CO_2 emission permits

- 100% Grandfathering (2003/87/EC Directive)
- 100% Auctioning (Ausubel (2004) rules)

2. EXPERIMENTAL DESIGN
(Botelho *et al.* (2011))



2. EXPERIMENTAL DESIGN

- Additional stage: **INVESTMENT**

DECISIONS ABOUT:

- Cost of investment and its consequences on participants' abatement costs (parameters).
- When to ask for investment decisions (which stage).
- One shot decision, repeated in all periods of the session; repeated cumulative investment decisions; unique/ irreversible decision.

2. EXPERIMENTAL DESIGN

Few experimental studies on EPM included this particular aspect: INVESTMENT decisions.

- Gangadharan, Farrel and Croson (2009)
- Camacho-Cuena, Requate, Waichman (2011)
- Nicklisch and Zucchini (2005)
- Ben-David *et al.* (1999, 2000)

2. EXPERIMENTAL DESIGN

Parameters:

- Constant cost of investment, equal to all participants but with different consequences on its marginal abatement costs (a 10% reduction on marginal abatement costs of 4 participants – the "less polutants" – and a 30% reduction for the other 4 participants – the "more polutants").

2. EXPERIMENTAL DESIGN

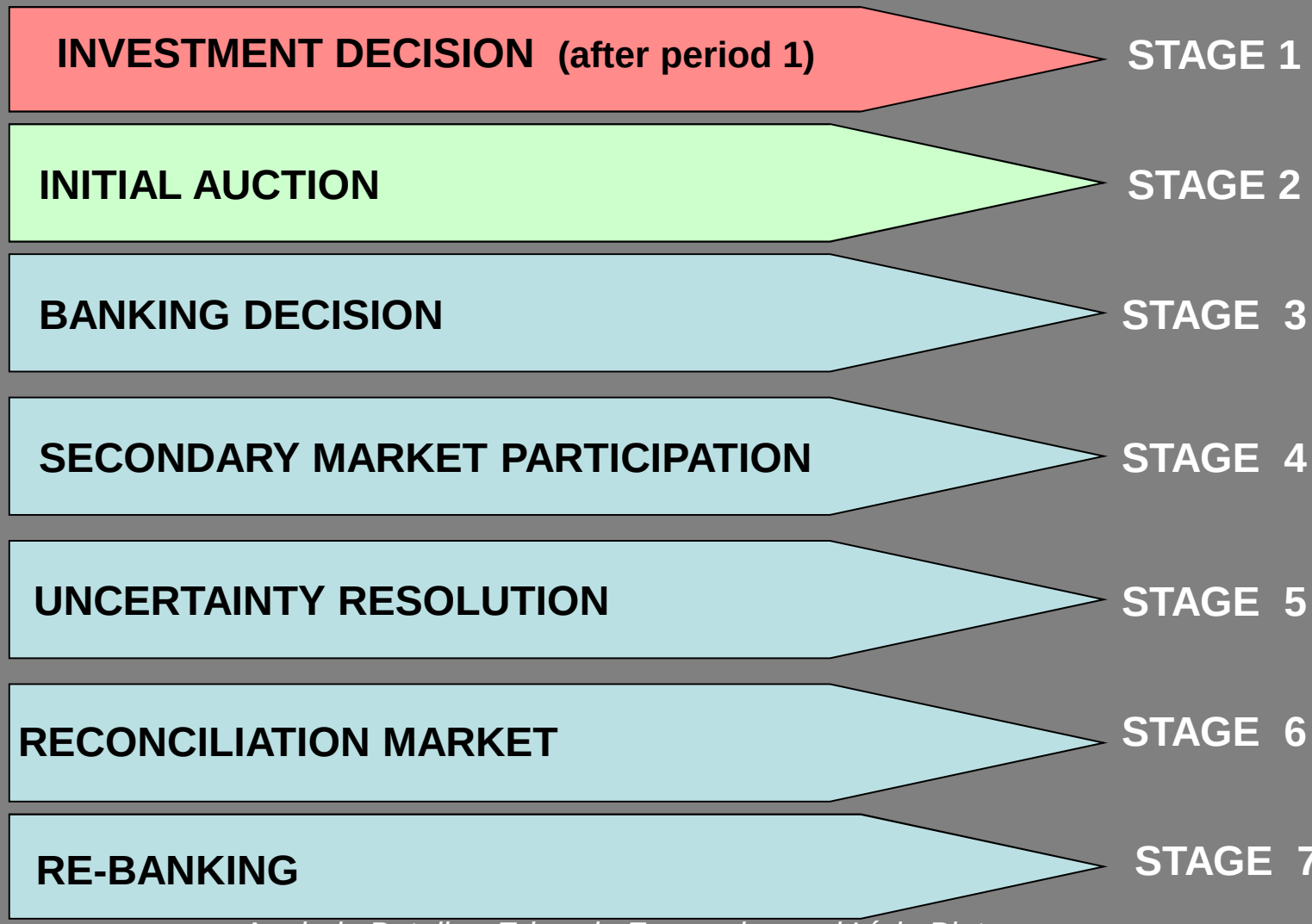
Parameters:

- Cost of investment strategically determined so as to, in equilibrium, only a subset of firms (4) would chose to invest (as Gangadharan's *et al.* (2009) did, for instance – but their decision to invest was public information whereas our was private).

2. EXPERIMENTAL DESIGN

- Decision about investment was asked at the beginning of every period (from the 2nd onwards)
- A one shot decision, repeated in all periods of the session (as Camacho-Cuena, Requate, Waichman (2011))
  - Irreversible investment decision mistakes avoided.
  - Opportunity of learning/ practicing this decision.

2. EXPERIMENTAL DESIGN



2. EXPERIMENTAL DESIGN

Computerized (zTree) experimental sessions:

1st PART	**SOCIOECONOMIC QUESTIONNAIRE**
2nd PART	**ELICITATION OF RISK AVERSION ATTITUDES**
3rd PART	**EMISSION PERMITS MARKET**

Stage 1: Investment

Periodo

3 em 10

Tempo Restante [sec]: 0

UNIDADES	CUSTO INICIAL	DADAS	CUSTO APÓS INVESTIMENTO
1	6		5
2	15		13
3	25		23
4	37		33
5	50		45
6	63		57
7	77		70
8	92	SIM	83
9	107	SIM	97
10	123	SIM	111
11	140	SIM	126
12	157	SIM	141
13	174	SIM	156
14	192	SIM	172
15	210	SIM	189
16	228	SIM	205
17	247	SIM	222
18	266	SIM	240
19	286	SIM	257
20	306	SIM	275
21	326	SIM	293
22	346	SIM	312
23	367	SIM	330
24	388	SIM	349
25	409	SIM	368
26	431	SIM	388

Este é o início do 3 período.

CUSTO DO INVESTIMENTO=70

Investe neste período?

- ○ SIM
- ◉ NÃO

Clique em SIM e OK caso decida investir: os seus custos serão iguais aos custos após investimento.

Caso decida não investir, clique em NÃO e OK: os seus custos serão iguais aos custos iniciais.

OK

Assegure que marcou a sua decisão final acima e que fez OK. Agora, clique em OK para continuar o período: 3

OK

Stage 1: Investment

Stage 2: Auction

Period

1 out of 3

Remaining Time [sec]: 591

UNITS	COST
1	40
2	60
3	110
4	180
5	260
6	350
7	450

Price = 130

You have 4 profitable units at this price.

Remember that your earnings in each unit equals COST-PRICE

Number of units I intend to buy at this price

Quantity

OK

Stage 2: Auction

Period

1 out of 3

Remaining Time [sec]: 596

UNITS	COST	ACQUIRED
1	40	
2	60	
3	110	
4	180	
5	260	YES
6	350	YES
7	450	YES

Your total earnings in the auction is of 490 points.

You acquired a total of 3 units at the following prices:

QUANTITIES	PRICES
0	130
0	160
3	190

OK

Stage 3: Banking

Period

1 out of 3

Remaining Time [sec]: 573

UNITS	COST	ACQUIRED
1	40	
2	60	
3	110	
4	180	
5	260	YES
6	350	YES
7	450	YES

PLAN OF USE OF THE ACQUIRED UNITS

Period	1	2	3	4	5	6	7	8	9	10	TOTAL
Acquired	3	0	0	0	0	0	0	0	0	0	3
Planed Use	3	0	0	0	0	0	0	0	0	0	0

TO CALCULATE TOTAL ACQUIRED UNITS PRESS OK

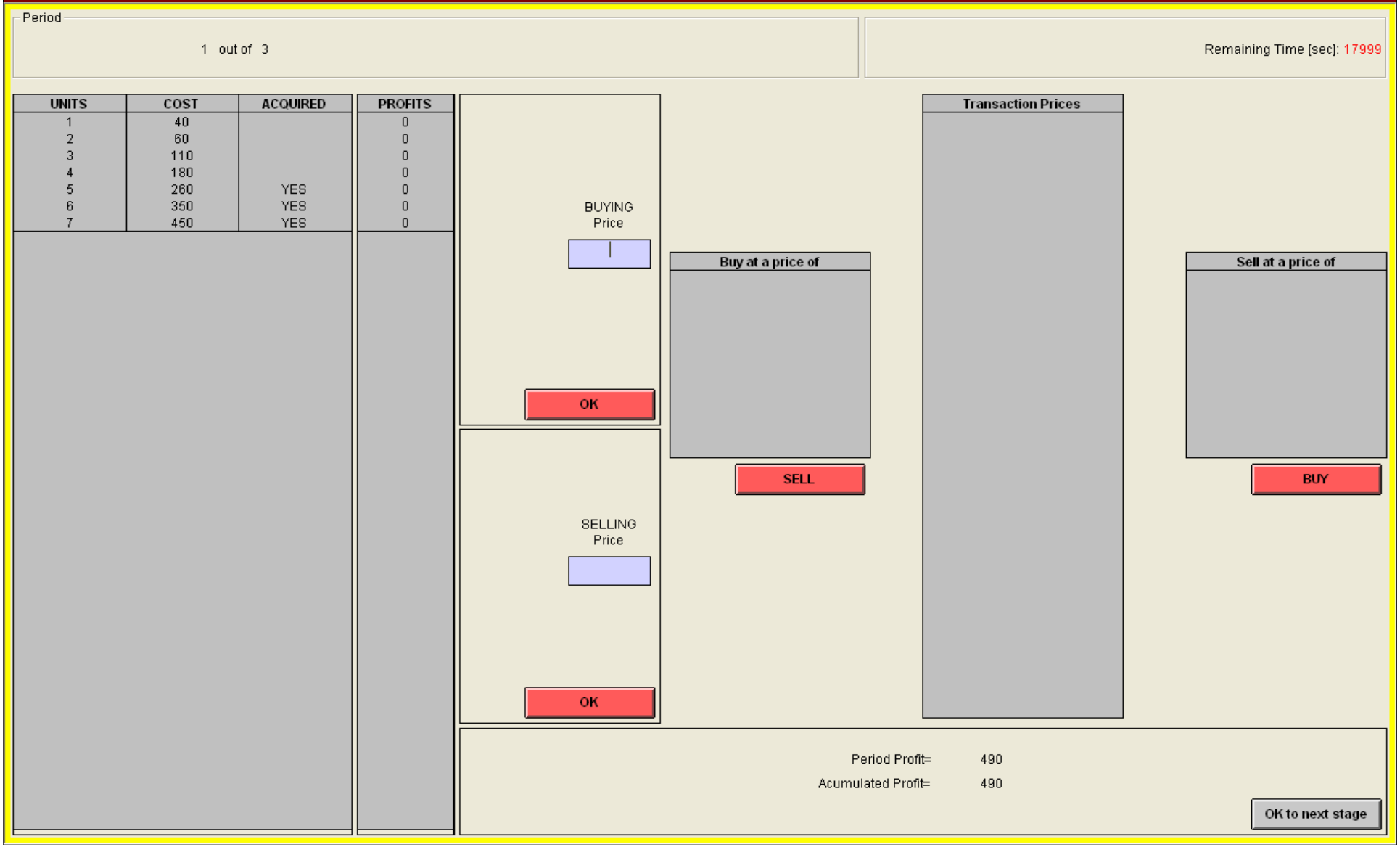
TOTAL

OK to next stage

Period Profit= 490

Acumulated profit= 0

Stage 4: Permits Market



Stage 5: Uncertainty resolution

Period

1 out of 3

Remaining Time [sec]: 30

UNITS	COST	ACQUIRED	PROFITS
1	40		0
2	60		0
3	110		0
4	180		0
5	260	YES	-260
6	350	YES	0
7	450	YES	0

Uncertainty Resolution

Variation on available units: 1

You have one more unit than predicted. It was unnecessarily supported the cost of unit number:

5

You might, however, try to sell it in the market that will open next or save it to next periods.

If you SELL it your earnings will be the Selling Price-Cost of that unit.

If you SAVE it your period earnings will decrease on the amount of its cost but in the future will be increased on the amount of the unit you will avoid to produce.

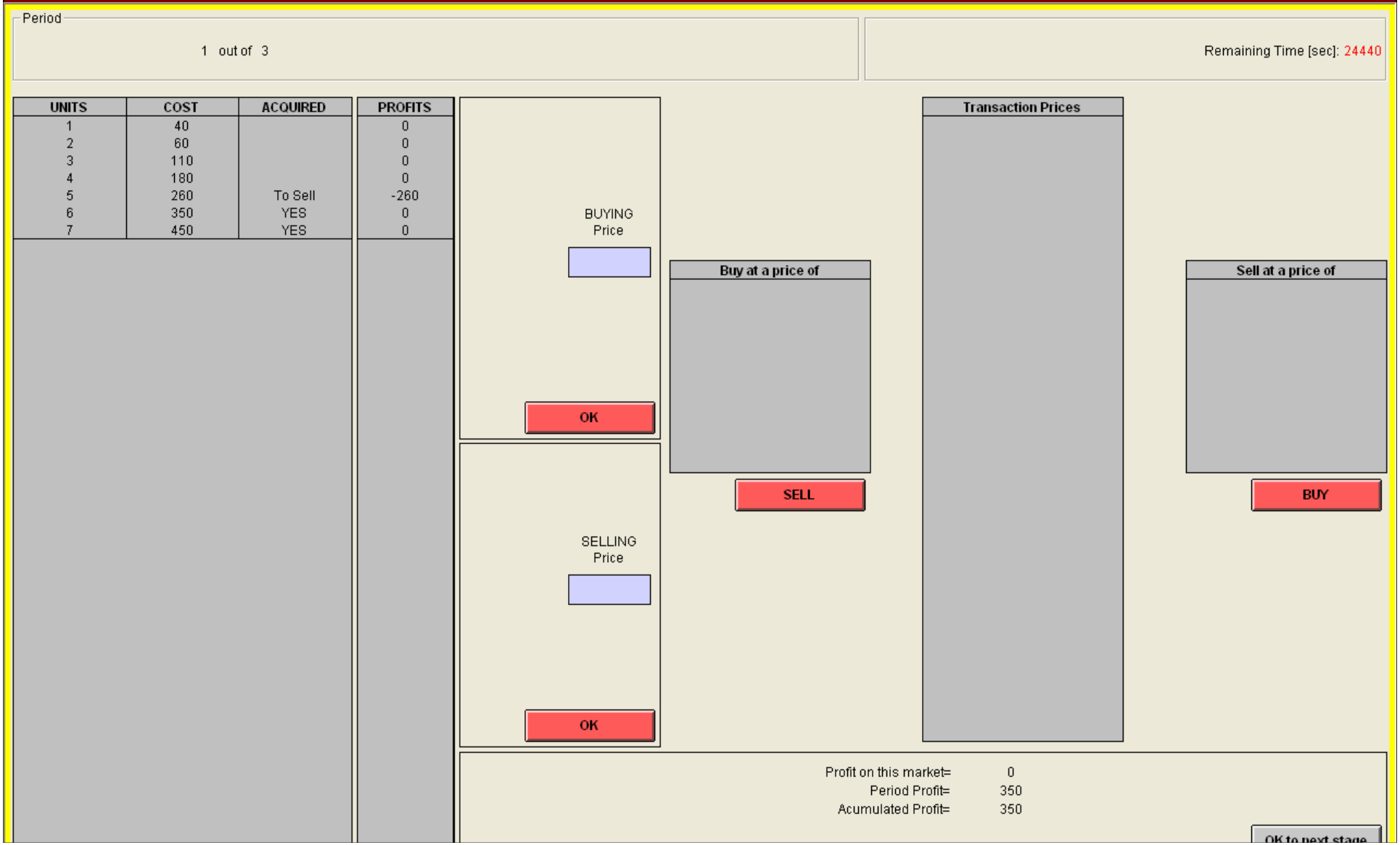
If you do nothing, that unit will have a negative impact on your eranings, corresponding to the value of its cost.

Uncertainty Impact on Profits= -260

Period Profit= 350

Acumulated Profit= 350

Stage 6: Reconciliation market



Stage 7: Re-banking

Period

1 out of 3

Remaining Time [sec]: 59

If you prefer, you may save this unit for the next period.

Do you want to save one unit now?

- YES
- NO

NOTE:

If you choose NO, you bear the cost of that unit, which afects your results in a negative way.

If you choose YES, you have one more unit saved for the next period.

After choosing, press OK to continue.

OK

OK to next stage

Period Profit= 350

Acumulated Profit= 350

3. Preliminary RESULTS

Only 2 Pilot Sessions run

- Grandfathering
- Auctioning (a bug on the 8th period did not allow the session to run its course until the end)

3. Preliminary RESULTS

- 39 decisions to invest in the **Grandfathering** treatment, which represents *overinvestment* (as 36 was the equilibrium prediction). However, from the subset of 4 firms that should chose to invest only 2 unequivocally did so – 9 decisions to invest out of 9 periods.

4. DISCUSSION / NEXT STEPS

Before running the real session experiments:

To review both treatment instructions (to make clearer to participants investment decision and its consequences).

In the auctioning treatment, to test the impact of having the decision to invest after the auction clears (???).

To run the real session experiments (hopefully, contributing with aditional knowledge about the importance of emission permits initial allocation mechanisms on incentives to invest in new abatement technologies).

Thank you for your attention!

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